WATER QUALITY AND QUANTITY SURVEY

VALLEYVIEW ROAD

TOWN OF VALLEY EAST

JANUARY 1978

Ministry
of the
Environment
Ontario

WATER QUALITY AND QUANTITY SURVEY

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1. INTRODUCTION

At the request (*) of the Regional Municipality of Sudbury a survey was conducted by staff of the Sudbury District Municipal and Private Abatement Section of the Ministry of the Environment to determine the need for a water supply system extension to service an area in the Town of Valley East. The proposed extension area is located along Valleyview Road, extending west from the industrial complex approximately 5,000 feet to Martin Road (see map, Appendix A). There are 13 dwellings in the study area.

* Reference - resolution adopted by Engineering Committee on June 16, 1977, and approved by Regional Council on June 22, 1977.

2. SURVEY PROCEDURES

The fieldwork, conducted by staff of this office on August 2 and August 23, 1977, consisted of the following procedures:

i) completing a well information sheet (see Appendix B) at every household in the study area.

ii) mapping the respective locations of the wells and buildings of every household in the study area.

iii) collecting drinking water samples from every household in the study area and forwarding these samples to the Sudbury and District Health Unit Laboratory in Sudbury for bacteriological examinations.

iv) collecting drinking water samples from every household in the study area and forwarding these samples to the Ministry of the Environment Laboratory in Toronto for chemical analyses. Parameters consisted of alkalinity, arsenic, apparent colour, total carbon, total organic carbon, inorganic carbon, chloride, conductivity, hardness, iron, pH, and turbidity. Additional parameters in 54% of the samples consisted of nitrates and sulfates.

v) conducting pumping tests to assess the quantity of water available. These tests consisted of determining the initial pumping rate (by recording the time required to obtain 2 gallons of water), letting the water run for a period of time, and then determining the final pumping rate.

vi) collecting information about the wells and the pumping systems at every household in the study area.

3. SURVEY RESULTS

3.1 General

The relatively thin overburden in the study area (ranging in depth from 0 to 20 feet) is composed of silt, sand, and gravel. The upland topography of the area is controlled by the profile of the granitic bedrock.

At the time of the survey one house was vacant. Therefore, although there are 13 houses (14 wells) in the study area, the survey procedures were conducted at only 12 residences (13 wells).

A total of 3(23%) of the 13 wells are dug wells (ranging in depth from 10 to 20 feet). The remaining 10(77%) wells are drilled wells (ranging in depth from 60 to 203 feet). Piston pumps are used for 4(31%) of the 13 wells. Jet pumps are used for 9(69%) of the wells.

3.2 Water Quality

During the survey water quality problems (mostly excessive iron and hardness) were reported by residents at 5(42%) of the 12 households.

Information about water quality parameters used for this survey are presented in the glossary (Appendix E).

The results of the bacteriological examinations indicate that only one sample contained coliform organisms. The well from which that sample was collected is no longer in use. Hence, the bacteriological quality of the water in the study area is considered to be excellent.

The results of the chemical analyses of the 13 drinking water samples are summarized in Appendix C. The problems indicated are as follows:

i) the recommended limit for apparent colour was exceeded in 7(54%) of the samples.

ii) the recommended limit for total organic carbon was exceeded in one(8%) of the samples.

iii) the recommended limit for conductivity (and hence, the dissolved solids concentration) was exceeeded in 5(38%) of the samples.

iv) a selected nuisance level (120 mg/l) for hardness was exceeded in all of the samples.

v) the recommended limit for iron was exceeded in 7(54%) of the samples.

These results indicate that the groundwater in this area is generally high in iron concentration and hardness.

There is a correlation between the iron content and the amount of apparent colour, and between the conductivity and the hardness levels.

3.3 Water Quantity

During the survey, water quantity problems were reported by residents at 7(58%) of the 12 households in the study area.

The water quantity information obtained is summarized in Appendix D.

For the purposes of this report a water supply problem is assumed to exist, if either of the following criteria are satisfied:

i) the final pumping rate is less than 1.0 gallon per minute.

ii) the decrease between the initial and the final pumping rate is greater than or equal to 50%.

These criteria are not exact indicators of inadequate water supplies. They are meant only to give an approximate evaluation of water quantity.

Therefore, using these criteria, water quantity problems existed at 6(50%) of the 12 households in the study area at the time of the survey.

4. DISCUSSION

4.1 Water Quality

The water quality problems that exist are mainly high iron concentrations and hardness levels.

Hardness levels can be reduced by the use of water softeners. A water softener consists of a tank containing synthetic zeolite. Sodium from the zeolite is exchanged by calcium and magnesium in the water. Because zeolites have a limited exchange capacity, it is necessary to regenerate the zeolite periodically with a solution of common salt (sodium chloride). During regeneration the calcium and magnesium salts are released from the zeolite, and, along with the common salt, are flushed out of the softener.

When iron concentrations are less than a few mg/l, a polyphosphate feeder or a water softener can be used to treat the water. Iron that occurs in groundwater is colourless. However, when exposed to air, as in pressure tanks or open containers, the iron readily changes its form and appears as a rusty precipitate. Instead of removing iron, polyphosphate keeps the iron in dissolved form. It therefore must be added before the water is exposed to air. Most zeolite softeners have a limited capacity to remove iron by exchange with sodium. Since the water must reach the softener before it is exposed to air, the softener is normally installed between the pump and the pressure tank.

For larger concentrations of iron either an iron filter or chlorination - filtration treatment can be used. An iron filter is similar to a water softener in appearance but contains manganese zeolite, an oxidizing agent, which precipitates the iron which is collected in the filter. Backwashing (with water) is required regularly to remove the collected iron and the zeolite must be periodically regenerated with potassium permanganate. However, where iron bacteria are present in the water, they will collect, grow, and readily foul the filter bed. The chlorination - filtration treatment involves the chlorination of the water (by means of a chlorinator unit) to oxidize and precipitate the iron, followed by filtration with a sediment filter to remove the iron precipitate. The addition of sodium carbonate (soda ash) may be necessary to raise the pH of water that has been treated with chlorine. In cases where iron bacteria are also present in the water, the addition of chlorine will control their growth in the water supply system.

High iron concentrations and hardness levels can be reduced by treatment at individual households.

4.2 Water Quantity

There are a number of possible causes for the water quantity problems in this area.

The limited depth of soil cover in the study area generally excludes overburden wells as an acceptable source of water supply.

The igneous bedrock in the area is also a poor aquifer containing only highly localized water-producing areas. Zones of small fractures, weathered zones, and permeable zones located near faults yield the most water to wells. The yield obtained is dependent on the number of joint planes intersected by the well. According to Davis and De Wiest (1) 5% to 20% (up to 50%) of wells in igneous rock may be failures. The locations and depths of the wells are therefore important factors in determining the quantity of water available.

Water shortages may also be caused by pump failures. Worn out seals in piston pumps, plugging or corrosion of jets in jet pumps, plugging of inlet screens, loss of prime due to leaking foot valves, and motor or control breakdowns may interrupt water supplies while water is still available. Pump failures may need to be referred to electricians, plumbers, pump suppliers or well contractors. Periodic pump maintenance is required to ensure that pumps continue to operate properly.

In other cases, the water may be lowered to a level where a shallow well pump cannot lift it to the surface (the practical lifting limit for shallow well pumps is approximately 22 feet). This situation can be corrected by installing a deep well (jet-ejector) pump. The water may also be lowered to a level where any type of pump cannot operate without drawing air. This situation can be corrected by lowering the pump intake, or it may be necessary to deepen the well.

(1) Davis, S.N., and R.J.M. De Wiest: "Hydrogeology," John Wiley & Sons, Inc., New York, 1966, p. 323.

At least 5 of the 6 systems that did not yield adequate water quantities used shallow well pumps.

Another method of increasing the quantity of water available from low-yield wells is to utilize larger storage tanks.

5. CONCLUSIONS

1) No serious water quality problems existed at the time of the survey. Those parameters that did exceed the recommended concentrations are not physiologically harmful and can be reduced to acceptable levels by treatment at individual households.

2) Water quantity problems existed at 6(50%) of the 12 households in the study area at the time of the survey.

3) Inadequate well depths and unfavourable well locations may contribute to the water quantity problems.

4) Pumping system deficiencies may contribute to the water quantity problems.

6. RECOMMENDATIONS

1) Those property owners who are concerned about their water quality should install the appropriate water treatment systems.

2) Those property owners who are concerned about their water quantity should take individual action to increase their water supply.

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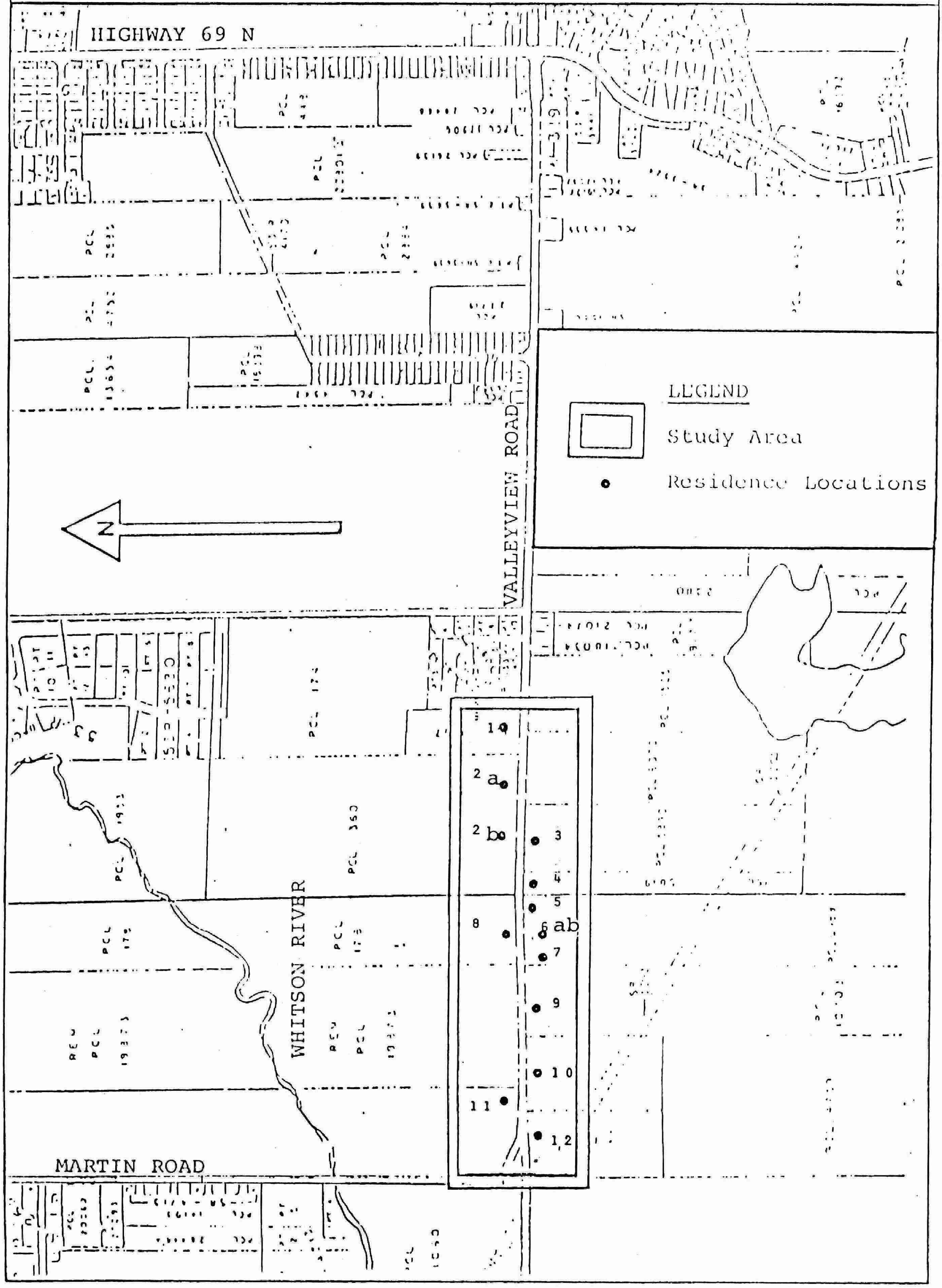
APPENDIX A

MAP OF STUDY AREA



WELL INFORMATION SHEET

APPENDIX B

OWNER:

Name: ______________________ Telephone No. (Business) ______________________
(Home) ______________________

Address: ______________________

OCCUPANT (If other than owner):

Name: ______________________ Telephone No. (Business) ______________________
(Home) ______________________

Address: ______________________

WELL LOCATION: Lot __________ Concession __________ Township __________

Please Supply Diagram of Well Location on Reverse Side:

WELL CONSTRUCTION DETAILS:

Date Constructed ______________________ Water Well Record(s) No. ______________________

Type ______________________ Diameter ______________________ Original Well Depth __________

Original Depth to Water Level ______________________

Well Completed Into: Bedrock ______________________ Overburden ______________________

Well Water Levels: (Measurments Taken from Top of Casing (F.T.C.)

Reference Point on Casing: Description, Location (Use Diagram If Necessary)

____

____

____

____

Height of Casing Above Ground Level: ______________ Elevation of Point ______________

Depth to Bottom of Well (F.T.C.) ______________

Water Level Measurements:

Date	Depth to Water Level (F.T.C.)	Depth of Water	Inspectors Initials

PLUMBING EQUIPMENT:

Pump Type __________ Make __________ Model No. __________ HP __________ Age __________

Depth of Intake Setting __________ feet (Original) Pumping Rate ______________________ gp

__________ feet (Present)

PREVIOUS PROBLEMS:

How long have you owned, operated or lived on this property? ______________________

Have you ever experienced any previous problems with your well? ____________

If so when? ____________

What was the cause of the previous problem? Drought ☐ Pump Failure ☐ Plugging ☐

Increased Usage ☐ Interference ☐ Quality ☐ Other (Please Specify)

How was the problem overcome? ____________

Did you ever have your well deepened or cleaned, or a new well constructed? ____________

If so, why? ____________

Outline briefly any previous repairs or changes in pumping equipment, and dates.

____

____

____

PRESENT PROBLEM: (If applicable)

Date of First Occurrence ____________

Water Level After Problem Began ____________

Suspected Cause of Problem ____________

Have you contacted the party you feel is causing this problem? ____________

WATER:

Use: Domestic No. ____________ Yes ____________ No. of Persons Using Water From Well ____________

Livestock No. ____________ Yes ____________ No. of Livestock Watered from Well ____________

Other ____________ Amount ____________

Equipment: Indoor Plumbing (eg: shower, automatic washer, etc.) ____________

____

Quality: Appearance (clear, cloudy) ____________

Taste ____________

Odour ____________

Sample Taken: No ____________ Yes ____________

PUMPING TEST (If Required)

Water Level in Well Immediately Prior to Pump Operation ____________ Fee

Below Measuring Point

Pumping Rate ____________ Gallons Per Minute ____________

(Pumping rate may be estimated by recording the time needed to fill a pail of known volume

Water Level in Well After ____________ Minutes of Pumping ____________

Below Measuring Point

I hereby certify that the above statements are correct to the best of my knowledge.

Signature ____________ Date ____________

TABLE 1

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SUMMARY OF CHEMICAL ANALYSES OF DRINKING WATER SAMPLES

PARAMETER	NO. OF SAMPLES	RANGE	AVERAGE	MEDIAN	RECOMMENDED LIMIT	% OF SAMPLES OVER RECOMMENDED LIMIT
Alkalinity (mg/l)	13	100-302	198	194	-	0
Arsenic (mg/l)	13	<0.001-0.003	0.001	0.001	0.01	0
Colour-Apparent (Hazen Units)	13	<5-100	24	10	5	54
Total Carbon (mg/l)	13	21-75	48	47	-	0
Total Organic Carbon (mg/l)	13	1-7	2.9	3	5	8
Inorganic Carbon (mg/l)	13	14-74	45	43	-	0
Chloride (mg/l)	13	1-214	88	64	250	0
Conductivity (umhos/cm)	13	257-1245	780	790	<667-909	38
Hardness (mg/l)	13	136-630	345	339	120 estimated	100 *
Iron (mg/l)	13	<0.05-5.8	1.5	0.35	0.3	54
Nitrates (mg/l)	7	<.1-4.6	0.96	0.2	10	0
pH	13	7.0-7.8	7.5	7.5	6.0-8.5	0
Sulfates (mg/l)	7	57-170	86	76	250	0
Turbidity (Formazin Units)	13	0.38-30	7.1	2.2	-	0

* Although there is no recommended limit for hardness, concentrations above 120 mg/l become increasingly inconvenient.

Information about the parameters and recommended limits is presented in the glossary (Appendix E).

APPENDIX C

TABLE 2

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SUMMARY OF WATER QUANTITY INFORMATION

LOCATION NO.	DEPTH OF WELL (FEET)	DIAMETER OF CASING (INCHES)	DEPTH OF IN-TAKE (FEET)	PUMP TYPE AND POWER	PUMP AGE (YEARS)	INITIAL PUMPING RATE (gal/min)	PUMPING TIME (minutes)	FINAL PUMPING RATE (gal/min)
1	18	36	17	1/3 H.P. Jet	6	2.7	10	2.7
2a	78	2	27	1/3 H.P. Jet	1	2.4	5	2.4
2b	**	**	**	**	**	**	**	**
3	158	2	158	1/3 H.P. Jet	3	3.0	10	2.6
4	203	2	203	1/2 H.P. Jet	7	3.0	5	2.7
5	189	2	**	1/3 H.P. Jet	7	4.0	10	2.7
6a	10	36	**	1/3 H.P. Jet	1	1.7	5	1.7
6b	95	1	95	1/3 H.P. Jet	6	3.0	5	0.9 *
7	100	2 1/2	28	1/3 H.P. Piston	2	1.8	5	0.67*
8	200	2	45	1 H.P. Jet	**	3.4	5	2.4
9	80	1 1/4	**	Piston	**	PUMP	NOT	OPERATING *
10	60	2	**	1 1/4 H.P. Piston	**	1.7	3	0 *
11	143	2	**	1 H.P. Jet	1	4.8	5	2.4 *
12	20	36	**	1/4 H.P. Piston	**	0	-	0 *

* Indicates inadequate water supplies

** Unknown

GLOSSARY

A. BACTERIOLOGICAL EXAMINATIONS

1. Coliform Bacteria

The direct search for a specific pathogen in water is too uneconomical and slow for routine control purposes. Instead water is examined for an indication of fecal contamination by using specific groups of bacteria as indicators. When these groups are found in the water it is assumed that the water is potentially harmful. The standard group of micro-organisms used as an indicator is the coliform group which includes all aerobic and facultative anaerobic, Gram-negative, nonspore forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35^{o}C. Organisms of the Escherchia coli strains which are usually of fecal origin, and of the intermediate and Aerobacter aerogenes strains which are usually but not always of soil, vegetable, or other non-fecal origin are included in this group.

1 (a) Total Coliforms

This group comprises species that are commonly associated with fecal matter (human and animal) and normal inhabitants of soil and vegetation. The presence of total coliforms in water may indicate contamination from soil runoff, or, less recent fecal pollution.

1 (b) Fecal Coliforms

These bacteria are mainly species associated with human and animal fecal matter. The presence of fecal coliforms in water indicates a relatively recent and near pollution input.

B. CHEMICAL ANALYSES

1. Alkalinity

Alkalinity is the measure of the power of a solution to neutralize hydrogen ions. It is used to define the buffering capacity (the capacity to resist changes in pH) of water. Alkalinity is expressed in terms of an equivalent amount of calcium carbonate. This does not necessarily imply that there is this much calcium carbonate in the water or that there is any at all. The alkalinity measurement represents the quantity of acid, expressed as calcium carbonate, needed to reduce the pH of a measured portion of sample to 4.5. It is caused by the presence of carbonates, bicarbonates, and hydroxides, and to a lesser extent by the presence of borates, silicates, phosphates, and organic substances. Alkalinity is not considered detrimental to human health but it is generally associated with high pH values, hardness and excessive dissolved solids.

2. Arsenic

Arsenic may be present in natural waters due to the dissolution of minerals (realgar, orpiment, arsenolite, mispickel and arsenopyrite), industrial discharges and pesticide applications. Arsenic is commonly found as inorganic oxyanions arsenite and aresenate, as the gas arsine, and as organic arsenicals such as methyl arsenate, phenyl arsenate and trimethylarsine. The element and its inorganic salts are highly

toxic to humans and are known to exhibit carcinogenic properties especially in the arsenate form. Arsenic is accumulated in body nails, hair and skin and is eliminated from the body very slowly. The maximum permissible concentration in domestic water supplies in Ontario is 0.01 mg/l.

3. Colour - Apparent

Apparent colour includes colour due to dissolved solids and suspended matter. Surface water colour is due mostly to the presence of humic acids derived from decomposition of plant material. In ground waters colour is usually due to the presence of iron and manganese. Most naturally coloured water (usually yellowish-brown) is harmless. The objective for domestic water supplies in Ontario is 5 Hazen Units.

4. Carbon (Total, Organic and Inorganic)

Both total carbon and inorganic carbon are determined by direct analysis on a liquid sample. The organic carbon component is obtained by taking the difference between the total carbon and the inorganic carbon. The total organic carbon content generally relates directly to the biochemical oxygen demand and the chemical oxygen demand. The total organic carbon is not a pollutant in itself but a measure of the degree of organic pollution. The recommended limit for domestic drinking water supplies in Ontario for total organic carbon is 5 mg/l.

5. Chloride

Chloride concentrations in water supplies may result from contact with natural minerals, industrial and agricultural wastes, or human and animal sewage. Urban runoff often contains high concentrations of chloride in the winter due to the application of road salt. Chlorides are generally not harmful. Allowable concentrations in drinking water are based on palatibility requirements rather than on health considerations. The water quality objective for domestic drinking water supplies in Ontario is 250 mg/l.

6. Conductivity

Conductivity is defined as the reciprocal of a water's electrical resistence (in ohms) between two electrodes one square centimeter in area and one centimeter apart at a standard temperature of 25°C. It is a measure of the ion concentration in water. In natural waters conductivity is mainly due to calcium, magnesium, sodium, potassium, bicarbonate, chloride, sulfate, and nitrate ions. Conductivity can be correlated with dissolved solids content. In Ontario the dissolved solids content is equal to 0.65 ± 0.10 times the conductivity. The permitted level for conductivity in drinking water in Ontario is indirectly established by the limit for dissolved solids.

7. Hardness

Hardness, defined as the soap neutralizing power of water, can be expressed in terms of an equivalent concentration of calcium carbonate. Hardness is mainly attributable to the presence of calcium and magnesium ions resulting from the natural accumulation of salts during contact with soil and geological formations. Hardness is objectionable because it reduces the efficiency of soap and it can produce scums and scales. Hardness in drinking water is limited indirectly by the criteria for dissolved solids (maximum of 500 mg/l). Concentrations over 120 mg/l become increasingly inconvenient.

8. Iron

Iron is the most abundant of the heavy metals in nature but despite this abundance it is generally found in relatively low concentrations in natural surface waters. In ground-water, however, conditions may be such that high concentrations of iron remain in solution. Iron concentrations occur in water due to the leaching of soluble iron salts from soil and rocks. Iron is non-toxic even at high concentrations but becomes objectionable in water because of the taste and odour it imparts. It also tends to precipitate as hydroxides staining laundry and procelain fixtures. Also, ferric iron combines with the tannin in tea to produce a dark violet colour. The water quality objective for drinking water in Ontario (0.3 mg/l) is based on aesthetic and taste considerations.

9. Nitrate Nitrogen

Nitrates are the end products of the aerobic stabilization of organic nitrogen and as such they occur in polluted waters that have undergone self-purification. They can occur in groundwater as a result of leachings from cesspools or fertilized soil. Photosynthetic action is constantly utilizing nitrates and converting them to organic nitrogen in plant cells but in groundwater this action is not possible and high concentrations of nitrates can result. Nitrates are undesirable because their nutritive properties promote the growth of algae and other aquatic plants. Although nitrates are considered non-toxic to adults, high levels in domestic water supplies can lead to a condition known as infant methemoglobinemia in which the oxygen carrying capacity of the blood is inhibited. The maximum acceptable level of nitrates for domestic water supplies in Ontario is 10 mg/l if the water is to be used for infant feeding.

10. pH

The symbol pH is used to designate the logarithm (base 10) of the reciprocal of the hydrogen ion activity. In the case of natural waters the hydrogen ion activity closely approximates the hydrogen ion concentration in moles per litre. Although the hydrogen ion is a potential pollutant in itself, pH is also intimately related to the concentrations of many other substances. The degree of dissociation of many substances is influenced by pH and since the undissociated compounds are frequently more toxic than the ionic forms pH may be a highly significant factor in determining limiting concentrations. Also the hydrogen ion concentrations is

important because it affects the taste and corrosivity of water and the efficiency of chlorination.

11. Sulfates

Sulfates occur naturally in water as a result of leachings from minerals. Sulfates may also occur as the final oxidized stage of sulfides, sulfites, and thiosulfates, as the oxidized state of organic matter in the sulfur cycle and as a result of industrial wastes. Water high in sulfates tends to form hard scales on plumbing and increase the corrosiveness of water towards concrete. Under anoxic conditions sulfates serves as an oxygen source for bacteria which convert it to hydrogen sulfide gas. The maximum sulfate concentrations permissible for domestic water supplies in Ontario is 250 mg/l. Although the limit is not based on taste or physiological considerations, concentrations over the limit may exert a cathartic effect on the gastro-intestinal tract.

12. Turbidity

Turbidity is a measure of the optical properties of a water sample. It is attributable to suspended and colloidal matter which diminishes the penetration of light. Turbidity is useful in assessing water clarity. In Ontario turbidity is measured in Formazin Units.

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